oscillating layer at the surface of the sensitive plate. Being anxious to keep the alcohol in the cell (which in this instance was closed by a ground glass cap), I sealed the cell into a glass tube through the extremities of which the wires of the cell passed. The effect of the disturbance thus resulting was that no amount of tapping the support of the cell would change it from the sensitive to the insensitive state, although before being thus treated it was sensitive to the most minute disturbance. I suspected, however, that after some hours the liquid and the plate would again enter into the peculiar relation on which the impulsion results depend, and so it turned out—after three hours the cell could be rendered insensitive by taps and sensitive by the inductive effect of a Voss machine. The platinum wires were *soldered* to the plates. I see that the distances at which I found the Hertz oscillator effective in influencing the cells were greater than those above stated; but I have not been able to renew work with the oscillator, which belongs to Mr. Gregory, who removed it for exhibition at the Royal Society's meeting.

May 16.

Bison not Aurochs.

I AM glad that Mr. Lydekker accedes (NATURE, May 15, p. 53) to the correction of which I had pointed out the need. But the "vulgar error"—if the Editor will allow me to use a phrase made classical nearly 250 years ago by Sir Thomas Browne—is of more ancient date than my friend seems to suppose; and Dr. Gadow has kindly referred me to Prof. Wrzesniowski's "Studien zur Geschichte des polnischen Tur," published in May 1878 (*Zeitschr. für wissenschaftl. Zoologie*, xxx. pp. 493-555). Therein will be seen reduced copies of the engravings in an edition of Herberstein's "Rerum Moscoviticarum Commentarii" (Basileæ: 1571), giving a figure of each of the animals. The first is inscribed

> VRVS SVM, POLONIS TVR, GERMANIS AVROX:
> IGNARI BISONTIS NOMEN DEDERANT.

Over the second may be read

> BISONS SVM, POLONIS SVBER, GERMANIS BISONT: IGNARI VRI NOMEN DEDERANT.

This paper is well worth reading from the amount of curious information to be found in it. I have been able to consult only one copy of this work, of an earlier edition indeed, for it was published at Antwerp in 1557; but it does not contain these figures, though the passages quoted by the Polish Professor of course occur (*ff.* 117 *verso et seqq.*). The figures are not remarkable for beauty, and if anyone were to call them caricatures I should hardly complain; but they are certainly of interest, and that of the Urus, which I think I have seen copied elsewhere, is perhaps the only approach to an original representation extant. If so it deserves to be better known. Allow me to remark that this is not the first time that I have noticed this error. I did so many years ago in a little pamphlet "On the Zoology of Ancient Europe" (p. 14), published by Messrs. Macmillan in 1862; and I may add that any visitor to the Museum of Zoology of this University may see therein a skeleton of the Aurochs and of the Bison, as well as of the American "Buffalo"—all standing side by side.

ALFRED NEWTON.

Magdalene College, Cambridge, May 18.

Sudden Rises of Temperature.

IN NATURE, vol. xli. p. 550, it is stated that sudden rises of temperature of large amount in Great Britain "are more frequent and more extensive in amount than sudden falls—the reverse to what obtains in India." There appears to be a somewhat similar condition of affairs in North America. Extremely sudden and large rises of temperature attend the warm Chinook winds, as they are called, which occur over the western part of the continent, but are unknown further east. Equally pronounced are the sudden falls of temperature in the eastern half of the country popularly termed "cold waves."

M. A. VEEDER.

Lyons, N.Y., May 7.

Coral Reefs, Fossil and Recent.

IN Dr. von Lendenfeld's communication to NATURE of May 8 (p. 30), occurs the following:—

"Dr. Murray goes on to say . . . and an isolated atoll rising precipitously, perhaps 10,000 feet from the sea-bottom, will be formed." And again—"and far less will it enable an atoll rising 10,000 feet or more from the bottom of the sea . . ."

I cannot think that the author quoted has committed himself to any such figures as these, but if either he or Dr. von Lendenfeld can tell me where to find such a formation in existing seas, I shall be obliged; as I have sought in vain for instances yet known of any slopes that could be called "*steep*" descending to more than 4000 feet or so, while *precipitous* slopes are unknown to me beyond 1200 feet; and these are, so far as I know, very exceptional.

While I am writing on this subject, I should be glad if anyone would explain how, on the assumption that atolls are formed during subsidence, it comes about that, while the outer slopes descend to great depths, the depth of the largest lagoons inclosed is generally confined to about 45 fathoms, and in one or two cases to 60 fathoms, but is never more. Why should not the lagoon of an atoll twenty or thirty miles in diameter, which rises steeply from depths of 200 or 300 fathoms or more, have a depth of at any rate 100 fathoms, allowing for the most extravagant amount of silt from the *débris* of the rim.

W. J. L. WHARTON.

Doppler's Principle.

A COMPLETE solution of the questions about which your correspondents are puzzling themselves has been before the public for some ten years in several successive editions of my "Deschanel." It occurs in the last paragraph of the chapter entitled "Numerical Evaluation of Sound," and is as follows:—

"Let the source make n vibrations per second. Let the observer move towards the source with velocity a. Let the source move away from the observer with velocity a'. Let the medium move from the observer towards the source with velocity m, and let the velocity of sound in the medium be v.

"Then the velocity of the observer relative to the medium is $a - m$ towards the source, and the velocity of the source relative to the medium is $a' - m$ away from the observer. The velocity of the sound relative to the source will be different in different directions, its greatest amount being $v + a' - m$ towards the observer, and its least being $v - a' + m$ away from the observer. The length of a wave will vary with direction, being $\frac{1}{n}$ of the velocity of the sound relative to the source. The length of those waves which meet the observer will be $\frac{v + a' - m}{n}$; and the velocity of these waves relative to the observer will be $v + a - m$; hence the number of waves that meet him in a second will be $\frac{v + a - m}{v + a' - m} n$."

The three quantities a, a', m may of course be either positive or negative.

J. D. EVERETT.

5 Princess Gardens, Belfast, May 17.

THE SHAPES OF LEAVES AND COTYLEDONS.[1]

ATTEMPTS to explain the forms, colours, and other characteristics of animals and plants, though not new, were until recent years far from successful. Our Teutonic forefathers had a pretty story which explained certain characteristics of several common plants.

Balder, the God of Mirth and Merriment, was, characteristically enough, regarded as deficient in the possession of immortality. The other divinities, fearing to lose him, petitioned Thor to make him immortal, and the prayer was granted on condition that every animal and plant would swear not to injure him. To secure this object, Nanna, Balder's wife, descended upon the earth. Loki, the God of Envy, attended her disguised as a crow (crows at that time were white), and settled on a little blue flower, hoping to cover it up so that she might overlook it. The flower, however, cried out "Forget-me-not, forget-me-not" (and has ever since been known under that name). Loki then flew up into an oak and sat on a mistletoe. Here he was more successful. Nanna carried off the oath of the oak, but overlooked the mistletoe. She thought, however, and the divinities thought, that she had successfully accomplished her mission, and that Balder had received the gift of immortality.

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[1] Lecture delivered at the Royal Institution on April 25, by Sir John Lubbock, Bart., M.P., D.C.L., F.R.S., &c.

One day, thinking Balder proof, they amused themselves by shooting at him, posting him against a holly. Loki tipped an arrow with a piece of mistletoe, against which Balder was not proof. This unfortunately pierced him to the heart, and he fell dead. Some drops of his blood dropped on the holly, which accounts for the redness of the berries; the mistletoe was so grieved that she has ever since borne fruit like tears, and the crow, whose form Loki had taken, and which till then had been white, was turned black.

This pretty myth accounts for several things, but is open to fatal objections. You will judge whether I am more fortunate. In the first place I need hardly observe that the forms of leaves are almost infinitely varied. To quote Ruskin's vivid words, they "take all kinds of strange shapes, as if to invite us to examine them. Star-shaped, heart-shaped, spear-shaped, arrow-shaped, fretted, fringed, cleft, furrowed, serrated, sinuated, in whorls, in tufts, in spires, in wreaths, endlessly expressive, deceptive, fantastic, never the same from footstalk to blossom, they seem perpetually to tempt our watchfulness, and take delight in outstripping our wonder."

Now, why is this marvellous variety, this inexhaustible treasury of beautiful forms? Does it result from some innate tendency of each species? Is it intentionally designed to delight the eye of man? Or has the form and size and texture some reference to the structure and organization, the habits and requirements, of the whole plant?

The leaf, although so thin, is no mere membrane, but is built up of many layers of cells, and the interior communicates with the external air by millions of little mouths, called stomata, which are generally situated on the under side of the leaf. The structure of leaves varies as much as their forms.

It is, of course, principally in hot and dry countries that leaves require protection from too much evaporation.

The surface is in some cases protected by a covering of varnish, in others by saline or calcareous excretions. In others, again, the same object is attained by increased viscidity of the sap; in some, the leaves assume a vertical position, thus presenting a smaller surface to the rays of the sun. In other cases the leaves become fleshy. Woolly hairs are also a common and effective mode of protection. The plants of deserts are very frequently covered with a thick felt of hair. Some species, again, which are smooth in the north tend to become woolly in the south. Species of the cool spring again tend to be glabrous. The uses of hairs to plants are indeed very various. They serve, as just mentioned, to check too rapid evaporation. They form a protection for the stomata or breathing holes, and consequently, as these are mainly on the under side of leaves, we find that when one side of the leaf is covered with white felted hairs, as the white poplar, this is always the under size.

In other cases the use of hair is to throw off water. In some Alpine and marsh plants this is important. If the breathing holes became clogged with moisture—with fog, for instance, or dew—they would be unable to fulfil their functions. The covering of hair, however, throws off the moisture, and thus keeps them dry. Thus these hairs form a protection both against too much drought, and too much moisture.

Another function of hairs which cannot be omitted is to serve as shades against too brilliant light, and too much heat. Again, hairs serve as a protection against insects, and even against larger animals. The stinging hairs of the common nettle are a familiar example, and coarse woolly hairs are often distasteful to herbivorous quadrupeds.

Deciduous leaves especially characterize the comparatively cool and moist atmosphere of temperate regions. For different reasons evergreen leaves become more numerous in the Alps and in the tropics.

In the Alps it is necessary for plants to make the most of the short summer. Hence, perennial and evergreen species are more numerous in proportion than with us. Everybody must have noticed how our trees are broken if we have snow early in the season and when they are still in leaf.

The comparatively tough and leathery leaves, such as those of the evergreen oak and olive, are protected against animals by their texture, and often, as in the holly, by spines; they are better able to resist the heat and dryness of the south than the comparatively tender leaves of our deciduous trees, which would part too rapidly with their moisture. It is perhaps an advantage to evergreen leaves to be glossy, because it enables them better to throw off snow. Moreover, their stomata are often placed in pits, and protected with hair, which prevents too rapid evaporation. The texture and structure of leaves is indeed a wide and very interesting subject, but to-night I must confine myself to the shape.

It is impossible to classify plants by the form of the leaf, which often differs greatly in very nearly allied species. Thus the common plantain of our lawn (*Plantago major*) has broad leaves, *P. lanceolata* narrow ones. The width or narrowness of leaves depends on various considerations. In herbaceous and stalkless plants, such as the plantain, prostrate leaves tend to be broad, those which are upright to be narrow. Thus, grasses, for instance, have more or less upright narrow leaves.

In other cases the width is determined by the distance between the buds, and in others again by the number of leaves in a whorl.

Cordate and Lobed Leaves.

Among broad leaves we may observe two distinct types, according as they are oval or palmate. Monocotyledonous plants, such as grasses, sedges, lilies, hyacinths, very generally have upright and narrow leaves. When they are wider, as, for instance, in the black bryony, this is mainly at the base, where, consequently, the veins are further apart, coming together again towards the apex. This we are tempted therefore to regard as the primitive type of a broad leaf.

There is, however, a totally different one, where the leaf is palmate, like a hand, widening towards the free end. Here the veins pursue a straight, diverging course; and as they not only serve to strengthen the leaf, but also to carry the nourishment, this is doubtless an advantage. Another reason perhaps for this arrangement is found in the fact that these leaves are generally folded up, like a fan, while they are in the bud.

I have elsewhere dwelt on the case of the beech, and perhaps I may briefly refer to it again. The weight of leaves which a branch can carry will of course depend on its position and strength. The mode of growth of the beech and the hornbeam are very similar, but the twigs of the latter are slenderer, and the leaves smaller. If we cut off a beech branch below the sixth leaf we shall find that the superficial leaf area which it carries is about 18 square inches. But in our climate most leaves are glad of as much sunshine as they can secure, and are arranged with reference to it. The width of the beech leaves, about $1\frac{3}{4}$ inch, is regulated by the average distance between the buds. If the leaves were wider they would overlap. If they were narrower there would be a waste of space. The area on the one hand, and the width on the other, being thus determined, the length is fixed, because, to secure an area of 18 inches, the width being about $1\frac{3}{4}$ inch, the length must be about 2 inches. This, then, explains the form of the beech leaf.

Let us apply these considerations in other cases. I will take, for instance, the Spanish chestnut and the black poplar. In the Spanish chestnut the stem is much stronger than that of the beech. Consequently it can carry a greater leaf-surface. But the distance between the buds being about the same the leaves cannot be much wider; hence they are much longer in proportion, and this gives them their peculiar sword-blade-like shape.

Now, if we look at the end of a branch of black poplar and compare it with one of white poplar, we are struck with two things: in the first place, the branch cannot be laid out on a sheet of paper so that the leaves shall not overlap; the leaves are too numerous and large. Secondly, in the white poplar the upper and under surfaces of the leaf are very different, the lower one being covered with a thick felt of hair, which gives it its white colour; in the black poplar, on the other hand, the two surfaces are nearly similar.

These two characteristics are correlated, for while in the white poplar the leaves are horizontal, in the black poplar, on the contrary, they hang vertically. Hence the two surfaces are under very similar conditions, and consequently present a similar structure; while for the same reason they hang free from one another.

Let us again look for a moment at the great group of Conifers. Why, for instance, do some have long leaves and some short ones? This, I believe, depends on the strength of the twigs and the number of years which the leaves last; long leaves dropping after one, two, or three years, while species with shorter ones retained them many years—the spruce fir, for instance, 8 or 10, *Abies Pinsapo* even as many as 18.

[Here Sir John dwelt on and explained the forms of several familiar leaves.]

Seedlings.

I now come to the second part of my lecture—the forms of cotyledons. Anyone who has ever looked at a seedling plant must have been struck by the fact that the first leaves differ entirely from those which follow—not merely from the final form, but even from those which immediately follow. These first leaves are called cotyledons. The forms of many cotyledons have been carefully described, but no reason had been given for the forms assumed, nor any explanation offered why they should differ so much from the subsequent leaves. Klebs, indeed, in his interesting memoir on "Germination," characterizes it as quite an enigma.

Mustard and cress were the delight and wonder of our childhood, but it never then occurred to me at least to ask why they were formed as they are. So they grew, and beyond that it did not occur to me, nor I think to most, that it was possible to inquire. I have, however, I think, suggested plausible reasons in many cases, some of which I will now submit for your consideration. Cotyledons differ greatly in form.

Some are narrow, in illustration of which I may mention the fennel and ferula, in the stalk or ferule of which Prometheus is fabled to have brought down fire from heaven.

Some are broad, as in the beech and mustard. Moreover, some species have narrow cotyledons and broad leaves, while others have broad cotyledons and narrow leaves.

Some are emarginate, as in the mustard; lobed, as in the lime; bifid, as in Eschscholtzia; trifid, as in the cress; or with four long lobes, as in Pterocarya.

Some are unequal, as in the mustard; or unsymmetrical, as in the geranium.

Some are sessile, and some are stalked; some are large, some small.

Generally, they are green, leaf-like, and aërial, but sometimes they are thick and fleshy, as in the oak, nut, walnut, peas, beans, and many others, in which they never quit the seed at all.

Let us see, then, whether we can throw any light on these differences, and why they should be so unlike the true leaves.

If we cut open a seed, we find within it the future plant: sometimes, as in the larkspur, a very small oval body; sometimes, as in the ash, or the castor-oil, a lovely little miniature plant, with a short stout root and two well-formed leaves, inclosing between them the rudiment of the future stem; the whole lying embedded in food-material or perisperm; while sometimes the embryo occupies the whole interior of the seed, the food-material being stored up, not round, but in the seed-leaves or cotyledons themselves. Peas and beans, almonds, nuts, and walnuts are familiar cases. In split peas, for instance,—who split the peas? If you look at them you will see that it is too regularly and beautifully done for human hands. In fact, the two halves are the two fleshy cotyledons: strictly speaking, they are not split, for they never were united.

Narrow Cotyledons.

Let us now begin with such species as have narrow cotyledons, and see if we can throw any light on this characteristic. The problem is simple enough in such cases as the plane, where we have, on the one hand, narrow cotyledons, and, on the other hand, a long narrow seed fully occupied by a straight embryo. Again, in the ash, the cotyledons lie parallel to the longer axis of the seed, which is narrow and elongated. Such cases are, however, comparatively few; and there are a large number of species in which the seeds are broad and even orbicular, while yet the cotyledons are narrow.

In these it will generally be found that the cotyledons lie transversely to the seed.

The sycamore has also narrow cotyledons, but the arrangement is very different. The fruit is winged, the seed somewhat obovoid and aperispermic—that is to say, the embryo, instead of lying embedded in food-material, occupies the whole cavity of the seed. Now, if we wished to pack a leaf into a cavity of this form, it would be found convenient to choose one of a long strap-like shape, and then roll it up into a sort of ball. This is, I believe, the reason why this form of cotyledon is most suitable in the case of the sycamore.

Broad Cotyledons.

I now pass to species with broad cotyledons. In the castor-oil plant, Euonymus, or the apple, for instance, the young plant lies the broad way of the seed, and the cotyledons conform to it. In the genus Coreopsis, *Coreopsis auriculata* has broad cotyledons, and *Coreopsis filifolia* has narrow ones—the first having broad, the second narrow seeds.

In a great many species the cotyledons are emarginate—that is to say, they are more or less deeply notched at the end. This is due to a variety of causes. One of the simplest cases is that of the oak, where the two fleshy cotyledons fill the seed; and as the walls of the seed are somewhat thickened at the end, and project slightly into the hollow of the seed, this causes a corresponding depression in the cotyledons.

In such cases as the mustard, cabbage, and radish, the emargination is due to a very different cause. The seed is oblong, thick, and slightly narrower at one end than the other. There is no perisperm, so that the embryo occupies the whole seed, and as this is somewhat deep, the cotyledons, in order to occupy the whole space, are folded and arranged one over the other like two sheets of note-paper, the radicle being folded along the edge. To this folding the emargination is due. If a piece of paper be taken, folded on itself, cut into the form of the seed, and then unfolded, the reason for the form of the cotyledon becomes clear at once.

But it may be said that in the wallflower the seed has a similar outline, and yet the cotyledons are not emarginate. The reason of this is that in the wall-flower, Cheiranthus, the seed is more compressed than in the mustard and radish, and consequently the cotyledons are not folded; so that the whole, not the half, of each cotyledon corresponds to the form of the seed.

Lobed Cotyledons.

The great majority of cotyledons are entire, but some are more or less lobed. For instance, those of the mallow are broadly ovate, minutely emarginate, cordate at the base, and three-lobed or angled towards the apex, with three veins, each running into one of the lobes.

The embryo is green, curved, and occupies a great part of the seed. The cotyledons are applied face to face; then, as growth continues, the tip becomes curved and depressed into a median longitudinal furrow, the fold of the one lying in that of the other.

[Sir John then showed clearly by diagrams and paper how the emargination arises, but it cannot be made clear without illustrations.]

The cotyledons of the lime are very peculiar. They are deeply five-lobed, the central lobe being the longest; so that they are roughly shaped like a hand. The seed is an oblate spheroid, resembling an orange in form, and the embryo is embedded in semi-transparent albumen.

The embryo is at first straight; the radicle is stout and obtuse; the cotyledons ovate-obtuse, plano-convex, fleshy, pale green, and applied face to face. They grow, however, considerably, and when they meet the wall of the seed, they bend back on themselves, and then curve round, following the general outline of the seed. If anyone will take a common tea-cup and try to place in it a sheet of paper, the paper will, of course, be thrown into ridges. If these ridges be removed and so much left as will lie smoothly inside the cup, it will be found that the paper has been cut into lobes more or less resembling those of the cotyledons of Tilia. Or if, conversely, a piece of paper be cut into lobes resembling those of the cotyledons, it will be found that the paper will fit the concavity of the cup. The case is almost like that of our own hand, which can be opened and closed conveniently owing to the division of the five fingers.

Unequal Cotyledons.

In most cases the two cotyledons are equal, but there are several cases in which one of them is larger than the other. They had not escaped the attention of Darwin, who attributed the difference to the fact "of a store of nutriment being laid up in some other part, as in the hypocotyl, or one of the cotyledons." I confess that I do not quite see how this affords any explanation of the fact. The suggestion I have thrown out is that the difference is due to the relative position of the two cotyledons in the seed, which in some cases favours one of them at the expense of the other. Thus in the mustard they are unequal, and, as we have already seen, they are folded up, one inside the other. The outer one, therefore, has more space, and becomes larger. In many other Crucifers, though the cotyledons are not folded, they are what is called "incumbent"—that is to say, they are folded on the radicle, and the outer one has therefore more room than the other.

Unsymmetrical Cotyledons.

In other cases, as in the geraniums, laburnum, lupines, &c., there is inequality, not between the two cotyledons, but between the two halves of each cotyledon. In the geraniums this is due to the manner in which the cotyledons are folded. In cabbage and mustard we have seen that one cotyledon is folded inside the other; in the geranium they are convolute, one half of each being folded inside one half of the other, the two inner halves being the smaller, the two outer the larger ones.

In the laburnum, where the arrangement is very similar, the inequality in the two sides of the cotyledon is due to the inequality between the two sides of the seed.

Subterranean Cotyledons.

I have already observed that in some cases the cotyledons occupy the whole of the seed, which, in more or less spherical seeds is effected either by a process of folding and packing, or by the cotyledons becoming themselves more or less thickened, as in peas and beans, nuts and chestnuts. This is the reason why such seeds fall more or less readily into two halves, the radicle or plumule being so small in comparison as generally to escape notice, though, if a horse-chestnut is peeled, the radicle appears as a sort of tail.

In some beans the cotyledons sometimes emerge from the seed, sometimes remain underground. In others, as also in the oak and horse-chestnut, they never leave the seed, or come above ground: they have lost the function of leaves and become mere receptacles of nourishment.

Did it ever occur to you to think, when you have been eating walnuts, why their structure is so complex, and why the edible part is thrown into those complicated lobes and folds? The history is very interesting.

In the walnut, the cotyledons now never leave the seed, but in an allied genus, Pterocarya, they come above ground as usual, and are very peculiar in form, being deeply four-lobed. The reason of this is very curious. The fruit is originally much larger than the seed, but, as it approaches maturity, the hard woody tissue disintegrates at four places, leaving thus four hollow spaces. Into these spaces the seed sends four projections, and into these four projections each cotyledon sends a lobe. Hence the four lobes.

Now in the walnut a very similar process takes place, only the hollow spaces are much larger, so that, instead of a solid wall, with hollow spaces occupied by the seed, it gives the impression as if the seed was thrown into folds occupied by the wall of the fruit. To occupy these spaces fully, the cotyledons themselves were thrown into folds as we now see them. The fruit of Pterocarya is much smaller than that of the horse-chestnut, which doubtless was itself formerly not so large as it now is. As it increased, the cotyledons became fleshier and fleshier, and found it more and more difficult to make their exit from the seed, until at last they have given up any attempt to do so. Hence these curious folds, with which we are so familiar, are the efforts made by the originally leafy cotyledons to occupy the interior of the nut. If you separate them, you will easily find the little rootlet, and the plumule with from five to seven pairs of minute leaves.

But perhaps you will ask me why I have assumed that in these cases the cotyledons have conformed to the seeds? May it not be that the seed is determined, on the contrary, with reference to the cotyledons? The size, form, &c., of the seeds, however, evidently have relation to the habits, conditions, &c., of the parent plant.

Let me, in illustration, take one case. The cotyledons of the sycamore are long, narrow, and strap-like; those of the beech are short, very broad, and fan-like. Both species are aperispermic, the embryo occupying the whole interior of the seed.

Now, in the sycamore, the seed is more or less an oblate spheroid, and the long ribbon-like cotyledons, being rolled up into a ball, fit it closely, the inner cotyledon being often somewhat shorter than the other. On the other hand, the nuts of the beech are more or less triangular: an arrangement like that of the sycamore would therefore be utterly unsuitable, as it would necessarily leave great gaps. The cotyledons, however, are folded up like a fan, but with more complication, and in such a manner that they fit beautifully into the triangular nut.

Can we, however, carry the argument one stage further? Why should the seed of the sycamore be globular, and that of the beech triangular? Is it clear that the cotyledons are constituted so as to suit the seed? May it not be that it is the seed which is adapted to the cotyledons? In answer to this we must examine the fruit, and we shall find that in both cases the cavity of the fruit is approximately spherical. That of the sycamore, however, is comparatively small, say $\frac{1}{5}$ inch in diameter, and contains one seed, which exactly conforms to the cavity in which it lies. In the beech, on the contrary, the fruit is at least twice the size, and contains from two to four fruits, which consequently, in order to occupy the space, are compelled (to give a familiar illustration, like the segments of an orange) to take a more or less triangular form.

Thus, then, in these cases, starting with the form of the fruit, we see that it governs that of the seed, and that of the seed, again, determines that of the cotyledons. But though the cotyledons often follow the form of the seed, this is not invariably the case: other factors must also be taken into consideration; but when this is done, we can, I venture to think, throw much light on the varied forms which seedlings assume.

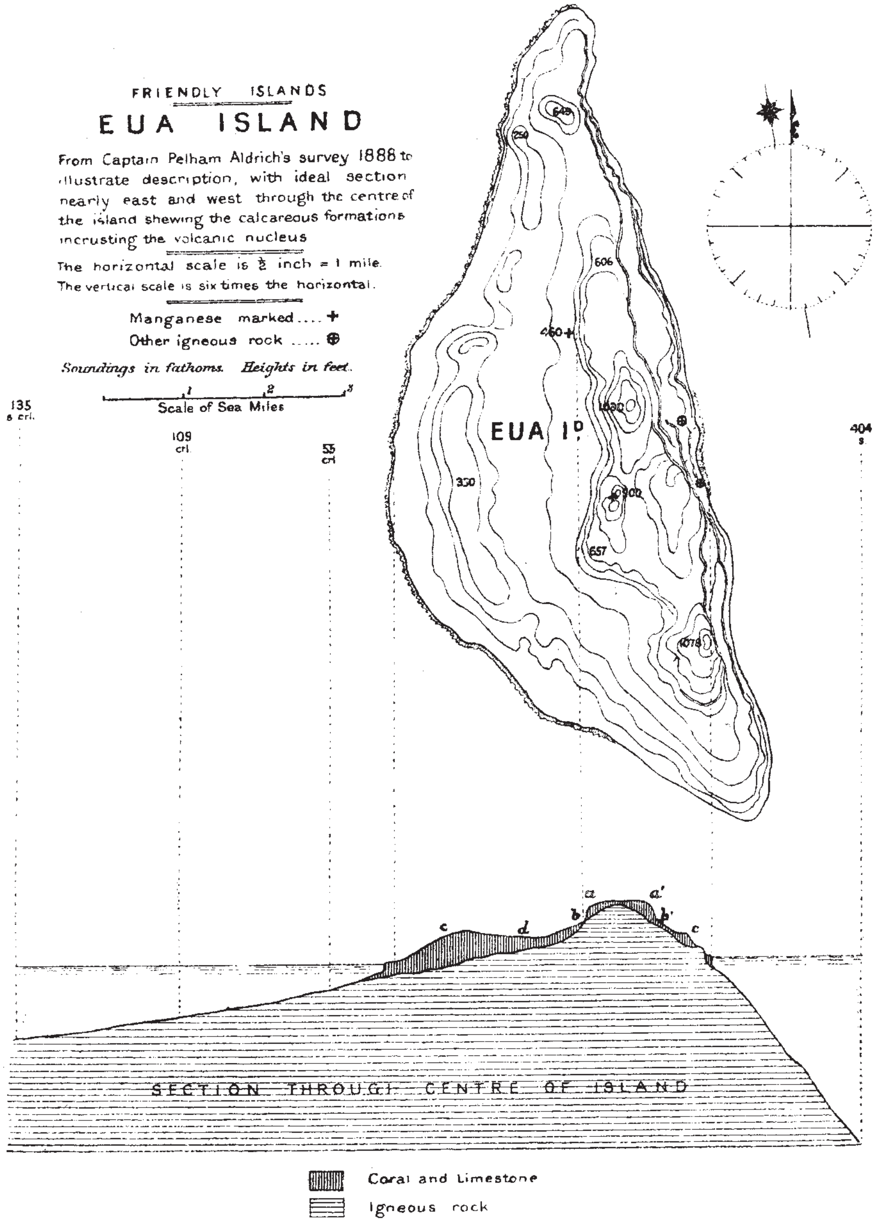
I have thus attempted to indicate some of the principles on which, as it seems to me, the shapes of leaves and seedlings depend, and to apply them in certain cases, but the study is only in its infancy: the number and variety of leaves is almost infinite, and the whole question offers, I venture to think, a very interesting field for observation and research—one, indeed, of the most fascinating in the whole of natural history.

EUA ISLAND, TONGA GROUP.

THE following description of Eua Island (one of the higher members of the Friendly or Tonga Islands, and familiar to readers of "Cook's Voyages" as Middleburgh), written by Commander Oldham, of H.M. surveying-ship *Egeria*, will be of interest to geologists and those interested in the coral controversy.

W. J. L. WHARTON.

"When viewed from the westward, Eua is seen to consist of grassy table-lands and slopes, having clumps of dark-green trees dotted here and there, giving it a park-like appearance. It is formed of two coral terraces resting on a volcanic nucleus. The upper terrace, about 600 feet above the level of the sea, rises to a summit 1030 feet high; the lower terrace attains a height of only 350 feet. On the western side of the island these terraces are separated a distance of from one to one and a half miles, and in some places there is a depression between them; the eastern side is very precipitous, the terraces there being very narrow, and forming cliffs at their seaward edges.



FRIENDLY ISLANDS

EUA ISLAND

From Captain Pelham Aldrich's survey 1888 to illustrate description, with ideal section nearly east and west through the centre of the island shewing the calcareous formations incrusting the volcanic nucleus

The horizontal scale is ½ inch = 1 mile.
The vertical scale is six times the horizontal.

Manganese marked .... +
Other igneous rock ..... ⊕

Soundings in fathoms. Heights in feet.

"The upper terrace seems composed of foraminiferous limestone and reef rock, with volcanic rock (a hydrated oxide of manganese) cropping out on the western side at the edge of the terrace where the coral rock has been removed by the effects of weather. The limestone is compact, reddish-brown, and largely foraminiferous. It is both *in situ* and scattered in detached blocks over the upper terrace, and when weathered has a honeycombed appearance.